MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2022/2023

ETN2016 – ANALOG COMMUNICATIONS

(All Section / Groups)

10 JULY 2023
9.00 a.m - 11.00 a.m
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This Question paper consists of 8 pages (including the cover page) with 4 Questions and Appendix.

2. Attempt all of the **FOUR** questions. All questions carry equal marks and the distribution of the marks for each question is given.

3. Please write all your answers in the Answer Booklet provided.

Question 1

(a) Differentiate between analog and digital waveforms. Draw a related diagram to support your answer.

[10 marks]

(b) The communication is more compact and useful when dealing with composite signal. Draw a frequency domain and time domain for composite signal which consists of three sine waves, each with different amplitude (5dB,10dB,15dB) and different frequency (0Hz,8Hz,16Hz).

[5 marks]

(c) Fourier series proved that a composite periodic signal with period T (frequency f) can be decomposed into a series of sine and cosine functions in which each function is an integral harmonic of the fundamental frequency f of the composite signal. In a square wave signal, given that A_n *is a* coefficients, A_o=0 because the average value of the signal is 0 and B_n=0 is oscillating above and below the time axis. The amplitude of the harmonics approaches zero as it is move toward infinity. Draw a frequency domain and time domain wave signal of square wave signal.

$$S = \frac{4A}{\pi}\cos(21tft) - \frac{4A}{3\pi}\cos(21t3ft) + \frac{4A}{5\pi}\cos(21t5ft) - \frac{4A}{7\pi}\cos(2\pi 7ft) + \cdots$$

$$A_o = 0, B_n = 0$$

$$An = \frac{4A}{n\pi} \text{ for } n = 1,3,9,\ldots \quad An = -\frac{4A}{n\pi} \text{ for } n = 3,7,11,\ldots$$

[5 marks]

(d) According to Fourier analysis, any composite signal is a combination of simple sine waves with different frequencies, amplitudes, and phases. Express the equation and draw a related diagram for the third harmonic term and the fifth harmonic term.

[5 marks]

Continued .....

Question 2

(a) Consider the double-sided magnitude spectrum of the message signal $G(f)$ illustrated in Figure Q2(a).

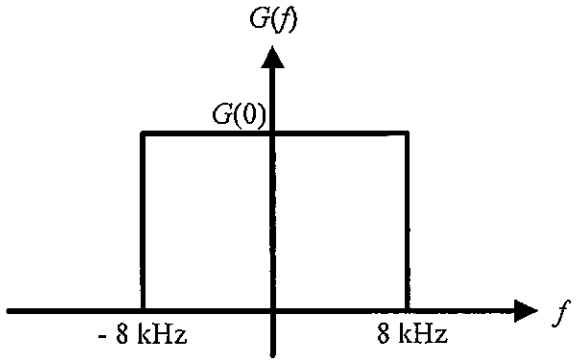

Figure Q2(a): Double-sided magnitude spectrum $G(f)$.

(i) Compute the minimum transmission bandwidth required if the double-sideband large carrier (DSB-LC) modulation scheme is used.

[2 marks]

(ii) Sketch the spectrum of the modulated signal if the double-sideband suppressed carrier (DSB-SC) modulation scheme is utilized. Assume that the amplitude and the frequency of the carrier signal are 1 V and 800 kHz, respectively.

[2 marks]

(iii) Calculate the total number of radio stations that can be simultaneously accommodated in a bandwidth of 35 kHz if all the radio stations adopt the DSB-SC modulation scheme and transmit the same message signal as shown in Figure Q2(a).

[2 marks]

(iv) State one advantage and one disadvantage of the DSB-LC modulation scheme in comparison to the DSB-SC modulation scheme.

[2 marks]

(v) Suggest two analog modulation techniques to improve the bandwidth efficiency of the DSB-SC scheme.

[2 marks]

Continued .....

(b) Draw a circuit and related waves of amplitude modulation which involve modulating signal, carrier frequency and modulated signal in analog communication.

[5 marks]

(c) Draw a diagram to differentiate between 4-quadrature amplitude modulation (QAM) and 8-QAM constellations.

[10 marks]

Continued .....

Question 3

(a) In frequency modulation, assume that a voice channel occupies a bandwidth of 4 kHz. If we need to combine three voice channels into a link with a bandwidth of 12 kHz, from 20 to 32 kHz, Show the configuration, using the frequency domain. Assume there are no guard bands. Draw a related diagram to support your answer.

[10 marks]

(b) A carrier signal is frequency modulated by a sinusoidal signal of frequency 18 kHz. Assume that the amplitude of the carrier signal is 1 V, the modulation index is 0.5 and the frequency modulated signal $g(t)$ is supplied to a load of 1ohm.

(i) By applying Carson's rule, calculate the bandwidth of $g(t)$.

[2 marks]

(ii) By applying the Table of Bessel functions of the first kind (at appendix), compute the bandwidth of $g(t)$.

[2 marks]

(iii) Calculate the average power of $g(t)$.

[1 mark]

(c) Frequency-division multiplexing (FDM) is an analog multiplexing technique that combines analog signals. Draw a FDM process which involve 3 baseband analog signals and 3 modulators.

[5 marks]

(d) In frequency-division multiplexing (FDM), assume there are five channels, each with a 100-kHz bandwidth, are to be multiplexed together. Determine the minimum bandwidth of the link if there is a need for a guard band of 10 kHz between the channels to prevent interference.

[5 marks]

Continued .....

Question 4

(a) In Figure 4(a), assume a signal travels through a transmission medium from Point 1 to 4.

(i) From point 1 to Point 2, if the power is reduced to one-half. Determine the attenuation (loss of power).

[2 marks]

(ii) From point 2 to Point 3, a signal travels through an amplifier, and its power is increased 10 times. Determine the amplification (gain of power).

[3 marks]

(iii) If fom point 3 to Point 4, the power is reduced to one-half, determine the decibel value from point 1 to 4.

[3 marks]

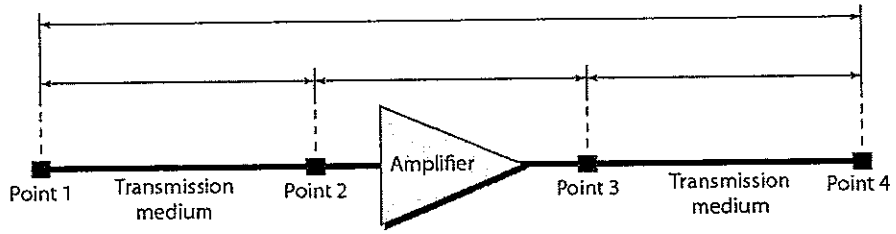

Figure 4(a)

(b) Design a superheterodyne amplitude modulation (AM) radio receiver that can be tuned to receive signals from 560 kHz to 1650 kHz. The intermediate frequency (IF) is set to 480 kHz by using low-side injection (low tracking).

(i) Calculate the required range of the local oscillator's frequencies.

[3 marks]

(ii) Compute the range of image frequencies.

[3 marks]

(iii) Determine the local oscillator's frequency and the image frequency when the receiver is tuned to a station at 1210 kHz.

[3 marks]

(iv) Calculate the image rejection ratio (IRR) in dB if the receiver is tuned to a station at 1210 kHz, the image rejection filter has a 32 kHz passband bandwidth and 40 dB/decade roll-off.

[3 marks]

Continued .....

(c) Given the power of a signal is 10 mW and the power of the noise is 1 μW. Determine the values of SNR and SNR_{dB}.

[2 marks]

(d) Provide THREE(3) disadvantages of Tuned RF Receiver (TRF).

[3 marks]

End of Paper

Appendix

n	$\beta = 0$	$\beta = 0.05$	$\beta = 0.1$	$\beta = 0.2$	$\beta = 0.3$	$\beta = 0.5$	$\beta = 0.7$	$\beta = 1$	$\beta = 2$	$\beta = 3$	$\beta = 5$	$\beta = 7$	$\beta = 8$	$\beta = 10$
0	1.000	0.999	0.998	0.990	0.978	0.938	0.881	0.765	0.224	-0.260	-0.178	0.300	0.172	-0.246
1		0.025	0.050	0.100	0.148	0.242	0.329	0.440	0.577	0.339	-0.328	-0.005	0.235	0.043
2			0.001	0.005	0.011	0.031	0.059	0.115	0.353	0.486	0.047	-0.301	-0.113	0.255
3					0.001	0.003	0.007	0.020	0.129	0.309	0.365	-0.168	-0.291	0.058
4							0.001	0.002	0.034	0.132	0.391	0.158	-0.105	-0.220
5									0.007	0.043	0.261	0.348	0.186	-0.234
6									0.001	0.011	0.131	0.339	0.338	-0.014
7										0.003	0.053	0.234	0.321	0.217
8											0.018	0.128	0.223	0.318
9											0.006	0.059	0.126	0.292
10											0.001	0.024	0.061	0.207
11												0.008	0.026	0.123
12												0.003	0.010	0.063
13												0.001	0.003	0.029
14													0.001	0.012
15														0.005
16														0.002
17														0.001

Table: Bessel functions